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(54) Scheduling process with resource checking capability

(57) Tasks (T) such as repair jobs on a telecommunications system, that are to be performed by a plurality of resources such as field engineers (E), at different locations in a geographical area (2), are scheduled by means of a scheduler (10) at a work manager server (5). The scheduler provides schedule data (11) corresponding to schedules of the tasks that individual ones of the resources are to carry out, from task data (4) concerning the tasks to be carried out and resource data (6) concerning characteristics of resources available to carry out the tasks over a given period. The schedule data (11) is downloaded to a workstation (7) for review. Checking procedures allow the downloaded data to be checked with respect to predetermined criteria such as the engineers' preferred working area, skill level and availability, to determine the capability of the engineers to perform tasks within the geographical area (2). The checking may be carried out using a map display.

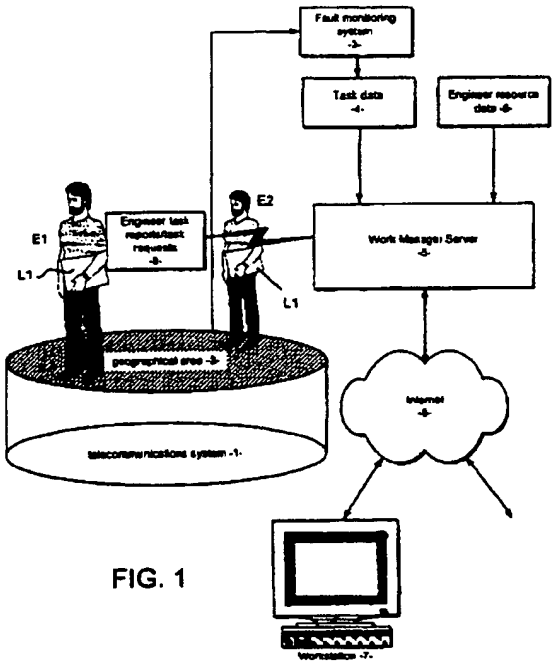

FIG. 1

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when the preferred working area for a selected engineer is displayed;
Figure 17 illustrates a drop down menu that is mouse-selectable to fill-in PWA circles;
Figure 18 illustrates the Tour Map window with PWA circles shaded to determine engineer coverage;
Figure 19 illustrates the Tour Map window when PWA circles overlie one another;
Figure 20 illustrates a dialogue box for performing a query to find engineers capable of performing a particular task;
Figure 21 illustrates a Tour Map window when the outcome of the query of Figure 20 is displayed;
Figure 22 illustrates a mouse-actuated drop down menu for selecting the PWAs of engineers, selected by means of the mouse;
Figures 23 and 24 are screenshots of a statistics display window;
Figure 25 illustrates a scheduler parameter editor window;
Figure 26 is a block diagram of a what-if process for displaying the outcome of changes the schedule data;
Figure 27 illustrates an engineer resource editor window;
Figure 28 illustrates a display of statistics produced by a what-if session; and
Figure 29 is a display window for comparing the outcomes of different what-if analyses.

System Overview

[0014] An overview of the system according to the invention is shown in Figure 1, for scheduling tasks to be carried out on a telecommunications system 1, shown schematically to extend over a geographical area 2. Engineers E1, E2... En carry out tasks on the telecommunications system to keep it in good repair.

[0015] It will be understood that the telecommunications system may extend over a large geographical area such as an entire country or state. Considering for example the United Kingdom (UK), there may be of the order of 20,000 people working on the system who typically carry out 150,000 tasks every day.

[0016] In order to simplify administration, the geographical area covered by the telecommunications system is broken down into service areas or domains which can be covered by individual groups of field engineers e.g. fifty engineers. For example, in country areas, the domains may cover geographical areas of the order of one county but in built-up areas, the geographical extent of a domain may be much smaller.

[0017] The telecommunications system may include a fault monitoring system 3 which identifies work to be carried out on the system. The fault monitoring system produces a list of tasks to be carried out by the field engineers together with information concerning the nature of the tasks and their geographical location. Each task is given an individual job identification number or JIN.

[0018] The resulting task data 4 is fed to a work manager server 5 that computes schedules of tasks to be carried out by the individual field engineers E1, E2... En. The work manager server handles tasks for the entire telecommunications system 1 although may conveniently comprise a number of network server processors distributed around the country.

[0019] The work manager server 5 is additionally fed with information concerning the field engineers E1, E2... En from an engineer data source 6. The engineer data includes rostering information i.e. holidays, sickness together with details of the skill level of the engineer for example whether they can work on telephone exchanges, optical fibres or other categories of system equipment. Each field engineer is given a personal identification number or PIN.

[0020] The engineers in each domain are organised in a number of individual organisational units which are given a unique organisational unit code or OUC. A (human) management controller for the domain is provided with a workstation 7 to receive management information concerning the schedules prepared for the individual engineers and other management information. The workstation 7 is configured to act as a client for the work manager server 5 and communication between the client and server is carried out by any suitable conventional method. In this example, communication is achieved through the Internet 8 although it will be appreciated that other wide area networks could be used. Thus, a plurality of workstations 7 communicate with the server 5 through the Internet 8 in order to provide management information to the individual organisational units associated with the domains. Only one workstation 7 is shown in Figure 1 in order to simplify the description.

[0021] Each engineer E in the domain is provided with a mobile computing facility such as a hand held terminal e.g. the Husky model FS/2 produced by Husky Computers Limited of Coventry England or a conventional laptop computer L1, L2. This enables the engineers to communicate individually with the work manager server 5, typically through the telecommunications system 1 or alternatively by mobile IP. When an individual engineer E logs onto the server 5, an individual work schedule is provided to the engineer by the server 5. The server periodically updates the schedule to optimise task allocation to the individual engineers. Thus, when a engineer completes a task, a report is provided back to the work manager server 5 in order to enable the server to keep an account of work carried out and to update and optimise the schedules. After completion of an individual task, the engineer is then provided with details of the next task to be carried out. In Figure 1, the communication of task completion reports and task requests is shown schematically by functional block 9.

[0022] The work manager server 5 is shown in more detail in Figure 2 and comprises a general purpose computer configured to operate as a server and provide the

to be explained in more detail hereinafter.

Downloading schedule data

[0032] The controller at workstation 7 can download schedule data 26 by using a main window 30 illustrated in Figure 5. Schedules for a particular domain can be selected by means of dialogue box 31. As previously explained, the work manager server 5 may in fact comprise a number of distributed servers around the country and dialogue box 32 permits selection of an appropriate local server.

[0033] The window 30 is provided with a button bar 33. Button 34 permits the latest schedule to be downloaded. Button 35 permits schedules to be archived into a selected archive folder 36. Folder 36 is a default archive folder and two other archive folders are shown which have been named by the user. Button 37 selects a statistics display and button 38 selects a parameter editing facility. Button 39 selects a Gantt chart to be described in more detail later and button 40 selects a display of a Tour Map, also to be described in more detail later. Button 41 allows a what-if analysis to be performed.

[0034] Four downloaded schedules 42, 43, 44 and 45 are shown in the window 30, held in a folder **wms** 46.

[0035] Considering the schedule 42 by way of example, it was created on 17 February 2000 at 16.09 hrs and relates to the domain MI which, as can be seen from dialogue box 31, is a domain around Greenford, to the west of London, UK. The schedule has been prepared by the HS/SA technique described previously and includes 115 tasks to be performed by 174 engineers over three days. The data in the file includes , the task data 4 and the engineer data 6 for the domain, together with schedule information produced by the scheduler 10 for each of the 174 engineers who are individually identified by their PINs. The tasks are individually identified by their JINs.

Gantt window

[0036] The Gantt chart generator 25b shown in Figure 4 operates on the schedule data to produce corresponding Gantt charts in a Gantt chart window 48 shown in Figure 6. The window includes two portions; window area 48a displays scheduled tasks and window area 48b displays unscheduled tasks. On the left hand side of the window, a vertical list 49a of the PINs of the individual engineers is displayed and each has a corresponding time line extending horizontally across the window 48a. Thus for PIN LWBDG01 a time line 50 is provided. Diamond symbols indicate the start and finish of the working day for the engineer concerned. Different categories of work activity are represented by different coloured elongate strips or blocks and a colour code legend is provided in a separate window (not shown). Considering for example the time line 51, the engineer concerned carries out two tasks indicated by strips 52, 53 and undergoes a period of travel 54 between the tasks 52, 53.

[0037] As previously mentioned. the schedule data files 42-45 each contain schedule data for three successive days and in the Gantt chart of Figure 6, the window 48 provides access to individual charts for the three days respectively, accessible by means of tabs 55, 56, 57.

[0038] The window 48 also has a search facility button 58 that allows the user to search for individual jobs and engineers by PIN and JIN.

[0039] Each task is given an importance score by means of the HS/SA scheduler 10. In this example, the tasks 52 , 53 have an importance score of 200 and 550 in Figure 6. Full task details of an individual task can be obtained by clicking the right hand mouse on the task block e.g. task 52 or 53 which provides a drop down menu (not shown) with an option to retrieve full task details from the schedule data, which is displayed in a floating window as shown in Figure 7.

[0040] As previously explained, unscheduled tasks are displayed in window 48b. A list of their location codes, comprising a letter code indicating a telephone exchange is given in vertical window 49b.

[0041] Each task in the schedule has a contingency figure associated with it. This comprises the number of "spare" minutes between the start time scheduled for a task and the projected latest start time, as projected by the scheduler 10. If the task were to start after this latest start time it would then fail. For an appointed task, for example, this latest start time is represented by the end of an appointment slot. The Gantt chart shown in Figure 6 can be operated by using a contingency control button 59 to display the contingency time for each task in a different colour set. This display gives an at-a-glance indication of tasks which are currently safe from failure, those with a relatively low contingency, those which have already failed to be handled by an engineer and those which are shown as being scheduled such that they will fail.

[0042] This display of contingency values allows the user at workstation 7 to identify problem areas and make a manual intervention to the scheduling scheme, if needed.

The Tour Map Window

[0043] The tour map window allows the schedule for individual engineers to be mapped as a tour on a map corresponding to the domain 2. Appropriate map data is downloaded from the map server 14 shown in Figure 2, to the workstation 7 and the tour map generation software 24 shown in Figure 4 operates on the schedule data to provide a pictorial display of the tour to be carried out by one or more field engineers as they move from task to task at different geographical locations according to their individual schedules specified in the downloaded schedule data 26.

[0057] To display only unscheduled tasks, a "scheduled task" option 90 in the map legend window shown in Figure 10, is disabled such that only unscheduled tasks, coded with a symbol ♦ are displayed at relevant locations in the map window 60. Alternatively, the unscheduled tasks can be displayed by clicking the right hand mouse button on the tours filter window 65 shown in Figure 8 so as to deselect all PINs and thereby hide their scheduled tasks on the map display in window 60.

[0058] The window 60, in response, displays only those tasks which were unscheduled at the time that the relevant schedule was run. The details of the unscheduled tasks can be displayed individually by using the mouse to click on them as previously described for scheduled tasks so as to provide a display corresponding to Figure 7 for an individual unscheduled task.

[0059] Figure 12 illustrates a partial, enlarged view of the tour map window 60 shown in Figure 8, when unscheduled tasks are displayed. The location of unscheduled task 91, disposed near the English town of Uxbridge is shown. Also, the current locations of field engineers are shown by the circular dots 92, 93, 94, 95, 96. Details of the current locations of the field engineers are shown in the display window area 72 by reference to their PIN and OUC. The selection of engineers to be displayed in this window is determined by right clicking on the relevant unscheduled task - task 91 in this example so as to provide a display in area window 72 concerning the PIN, OUC, distance and travel time of adjacent field engineers. This information is computed by the tour map software 25a shown in Figure 4. Thus, the operator at workstation 7 can determine how best to deal with unscheduled tasks e.g. in an emergency situation, in which an engineer needs immediately to be dispatched to deal with the unscheduled task. Thus, the operator at workstation 7 can manually override the schedules provided by the work manager server 5.

[0060] Figure 13 illustrates the process carried out by the Tour Map software generator 25a to produce the display of engineers in window area 72. At step S13.1, relevant engineer data are obtained from the engineer data 6 shown in Figure 1. The engineer data may relate to all the engineers for the domain or a selected group of them. The selection process is described in more detail hereinafter with reference to the Find Task Engineer Query.

[0061] Then, at step S13.2, the task location data for the unscheduled task, that has been selected by means of the mouse cursor, is compared with the location data for each individual engineer so that at step S13.3, the relative distance and the time to travel to the unscheduled task is computed for each engineer.

[0062] Then, at step S13.4, the engineer data is ranked in order of preference on the basis of the time taken to travel to the unscheduled task. However, alternative rankings may be used, such as the distance to travel to the unscheduled task. The resulting data is then displayed in the window area 72 shown in Figure 12.

PWA Query Tool

[0063] When the Tour Map window 60 is initially opened, no field engineer data is displayed in the window 72 and only the task locations are displayed on the map in window 60, together with travel arrows, if selected.

[0064] In order to determine the location of a specific field engineer or group of engineers who fit certain criteria, a PWA query tool is selected from the button bar using button 99 shown in Figure 8. This displays a PWA query dialogue box as shown in Figure 14. The dialogue box allows certain search criteria to be set in respect of field engineers. Data selection fields, which use drop down menus (which can also be overtyped) are provided to set up the search criteria. Field 100 sets the domain, field 101 the date and field 102 sets the OUC.

[0065] There are a number of further fields which select details from the engineer data 6 described with reference to Figures 1 and 2. An Attendance field 103 allows engineers to be selected on the basis of whether they are rostered in (i.e. working), rostered off, absent (e.g. on holiday) or all engineers can be selected.

[0066] Field 104 permits engineers to be selected in terms of their skill levels. As previously described, the engineer data indicates the skill levels of individual engineers.

[0067] Field 105 permits engineers to be selected depending on whether they are a member of a closed user group or CUG. These groups may be for specific secure or specialist areas such as banks, particular industrial sites and the like where only engineers with a predetermined security clearance are allowed access.

[0068] Field 106 allows a preferred working area or PWA for the engineers to be selected. Each engineer has a preferred working area which is displayed on the maps as circle centred on a particular telephone exchange from which the engineer usually operates. Four menu choices are provided. A "normal" PWA comprises a circle of a predetermined radius based on the telephone exchange.

[0069] An "interrupt" option permits the radius of the PWA circle to be expanded in order to increase the effective mobility of engineers in order to deal with the occurrence of e.g. a very important urgent task. A "start of day" option allows the PWA to be modified to take account of the distance that an engineer may need to travel from home at the start of the day. The "extended" option allows the PWA circle radius to be enlarged for example to deal with situations where only a few engineers are available e.g. due to sickness and a decision is made deliberately to increase the working area to deal with the resulting engineer resource shortfall.

[0070] When the fields have been appropriately set, a run query button 107 is operated, which results in a display in the window area 72 as shown in Figure 15.

[0071] The PINs of engineers which satisfy the search criteria are displayed in a column 108 together with a

start time for the task is given in column 144 and a [?] is given in column 145.

[0083] In the map window, details for the first three engineers listed in display area 72 are provided namely for display lines 146, 147, 148, shown highlighted. The default display for map window 60 includes the current and next location for each field engineer but further details may optionally be displayed. In the example of Figure.20, the preferred working locations for the three engineers are shown at 149, 150 and 151. Furthermore two of their PWAs are shown at 152 and 153.

[0084] It will be appreciated that the Find Task Engineers Query box in Figure 20, when used for an unscheduled task, i.e. by clicking the mouse on an unscheduled task, provides details of engineers available to perform the task which can be displayed as shown in Figure 12, as previously described.

Engineer Locations

[0085] As already described, only the locations of selected engineers displayed in the display area 72 of window 60 may be displayed on the map. Further control of which engineers are displayed can be achieved by clicking the right hand mouse button a blank area of the map to provide the drop down menu shown in Figure 17, and then selecting a "show locations for" menu option 154 which offers two further options as shown in Figure 22. When "all selected engineers" option 155 is selected, which is the default, the engineers' tasks are displayed as previously described with reference to Figure 8. However, when option 156 is selected, then only the PWA circles for the selected PINs displayed in area 72 are shown, as before, but none of the task locations are displayed until the mouse pointer is placed over a particular PWA circle. Then the location of all types of tasks for that engineer are displayed irrespective of the map legend selections made in the map legend window shown in Figure 10. This option is particularly useful for browsing through each relevant engineer to determine their location with respect to their PWA. It also reduces clutter when it is desired to see all types of locations for each engineer.

[0086] When this option is selected, moving the mouse pointer onto a PWA circle causes it to be displayed in bold and the start, current and preferred and, where appropriate, next location for that engineer only are then displayed on the map. If the PINs mobility limit is greater than the PWA radius, this is shown as a second circle in red, at an appropriate distance from the PINs current location. If the mobility distance is the same as the PWA radius, and the current location is also the preferred location then, on placing the mouse pointer on the PWA circle, the circle is again made bold, but now in red indicating that the two are superimposed.

Statistics Display

[0087] The workstation control software 25 includes a statistics generator 25c that can be selected by means of the statistics button 37 on the main window shown in Figure 5. Displays produced by the statistics generator software 25c are shown in Figures 23 and 24. The software acts on a selected individual schedule e.g. schedule 41 in respect of the three successive days data therein, to provide totals and averages as shown in screen display 157, in Figure 23. As shown in Figure 24, the display also includes quality of service or QOS indicators, shown in screen 158. The statistical display software 25c also can provide graphical displays of the corresponding data (not shown).

Parameter Editor

[0088] As previously described, the HS/SA scheduler 10 shown in Figure 2 makes use of scheduling algorithms that include a number of adjustable parameters 15, which can be edited by means of parameter editor controller software 25e shown in Figure 4. The parameter editor software is actuated by means of button 38 on button bar 33 of Figure 5, as a result of which a display of the parameters is provided on output display 16 as shown in Figure 25. A detailed discussion of the scheduler parameters is given in our PCT/WO98/22897 ***supra***. In Figure 25, the parameters are displayed over six pages and have been downloaded from the work manager server 5. Some of the workstations 7 will be provided with authority to change the parameters for the scheduler 10 and to upload revised values of the individual parameters. This is achieved in Figure 25 by placing new values of the parameters concerned in the "new" column 159, to replace the current values shown in column 160. Column 161 provides a default value for each individual parameter. A usual range is presented in column 162 and the units concerned in column 163.

[0089] The parameter editor can also be used to analyse the parameters for a particular set of schedule data 26 which, as previously described, may include scheduler parameter data 15, corresponding to the parameters actually used when preparing the schedule data by means of the scheduler 10. The parameter data derived from the schedule data 26 can also be edited, particularly for use in a what-if analysis. This is achieved by selecting one of the schedule data files, such as file 42 in the main window of Figure 5, so as to display the scheduler parameter data from the selected file in the parameter editor.

What-if Analysis

[0090] As previously described, the scheduler 10 shown in Figure 2 continually updates schedules and provides tasks to the individual engineers in response to task requests 9. The workstation 7 can carry out what-

weather conditions, traffic congestion and other non-standard situations.

[0103] Also, the what-if analysis may provide insights into how the rostering and work patterns of engineers can be changed, which can be fed into engineer data 6 for the future, in order to improve and optimise the task scheduling.

[0104] Many modifications and variations to the described example of the invention are possible and, whilst the invention has been described in relation to a telecommunications system, it can be used to process tasks relating to other situations where resources need to be applied to carry out the tasks concerned. For example, other situations where field engineers are deployed. The invention could also be used for work scheduling in an industrial process situation. Many other applications will be evident to those skilled in the art.

Claims

1. A method of scheduling tasks (T) at different locations in a geographical area (2) that are to be performed by a plurality of resources (E), comprising:

   providing schedule data (11) corresponding to schedules of the tasks that individual ones of the resources are to carry out, prepared from task data (4) concerning the tasks to be carried out and resource data (6) concerning characteristics of resources available to carry out the tasks over a given period, and
   checking with respect to predetermined criteria (100-106) the capability of the resources to perform tasks within the geographical area.

2. A method according to claim 1 including selectively determining the predetermined criteria used in the checking (130).

3. A method according to claim 1 or 2 wherein the criteria include a preferred working area (PWA) for each resource within the geographical area, and the checking includes making a determination of the configuration of the PWAs relative to the geographical area.

4. A method according to claim 3 wherein the PWA has selectible different values and the checking includes making a determination of the configuration of those of the PWAs with the selected PWA value relative to the geographical area.

5. A method according to claim 3, 4 or 5 including wherein the criteria include a selectible resource skill level and the checking includes making a determination of the configuration of those of the PWAs with the selected skill level relative to the geographical area.

6. A method according to any one of claims 3 to 6 wherein the criteria include a selectible resource availability and the checking includes making a determination of the configuration of those of the PWAs with the selected availability relative to the geographical area.

7. A method according to any one of claims 3 to 6 including displaying the PWAs of the selected resources on a map of the geographical area.

8. A method according to any one of claims 3 to 7 including determining if parts of the geographic area are not covered by the PWAs of the selected resources.

9. A method according to claim 8 including displaying the PWAs as circular areas on the map with a predetermined shading.

10. A method according to claim 8 or 9 including displaying on the map the locations of the tasks scheduled to be performed by at least one of the resources.

11. A method according to claim 8, 9 or 10 including displaying the location of at least one task that has not been scheduled to be performed by at least one of the resources.

12. A method according any preceding claim wherein the geographic area comprises a plurality of domains and the checking is carried out for the domains individually.

13. A method according to any preceding claim wherein the resource data (6) relates to field engineers (E) and the task data relates (4) to work to be carried out by the engineers on a system (1) distributed through out the geographical area (2).

14. A method according to any preceding claim including performing the checking on the schedule data (11, 26).

15. A method according to any preceding claim wherein the schedule data is provided by receiving it as a download from a remote server (5).

16. A computer program (10, 25) to be run on a computer to perform a method according to any one of the preceding claims.

17. A computer software configuration to be run on a computer (7) for supervising the scheduling of tasks (T) at different locations in a geographical area (2)

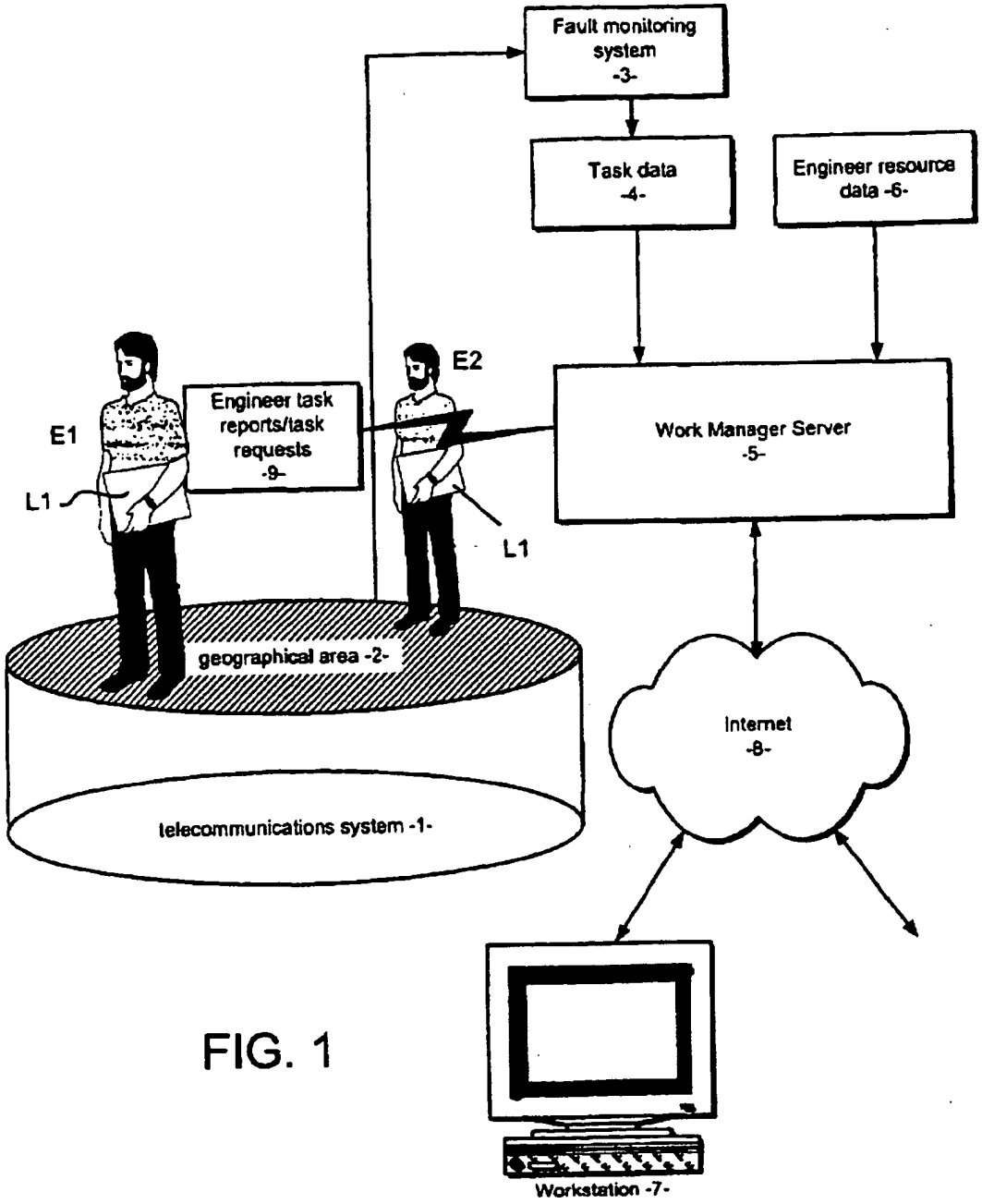


FIG. 1

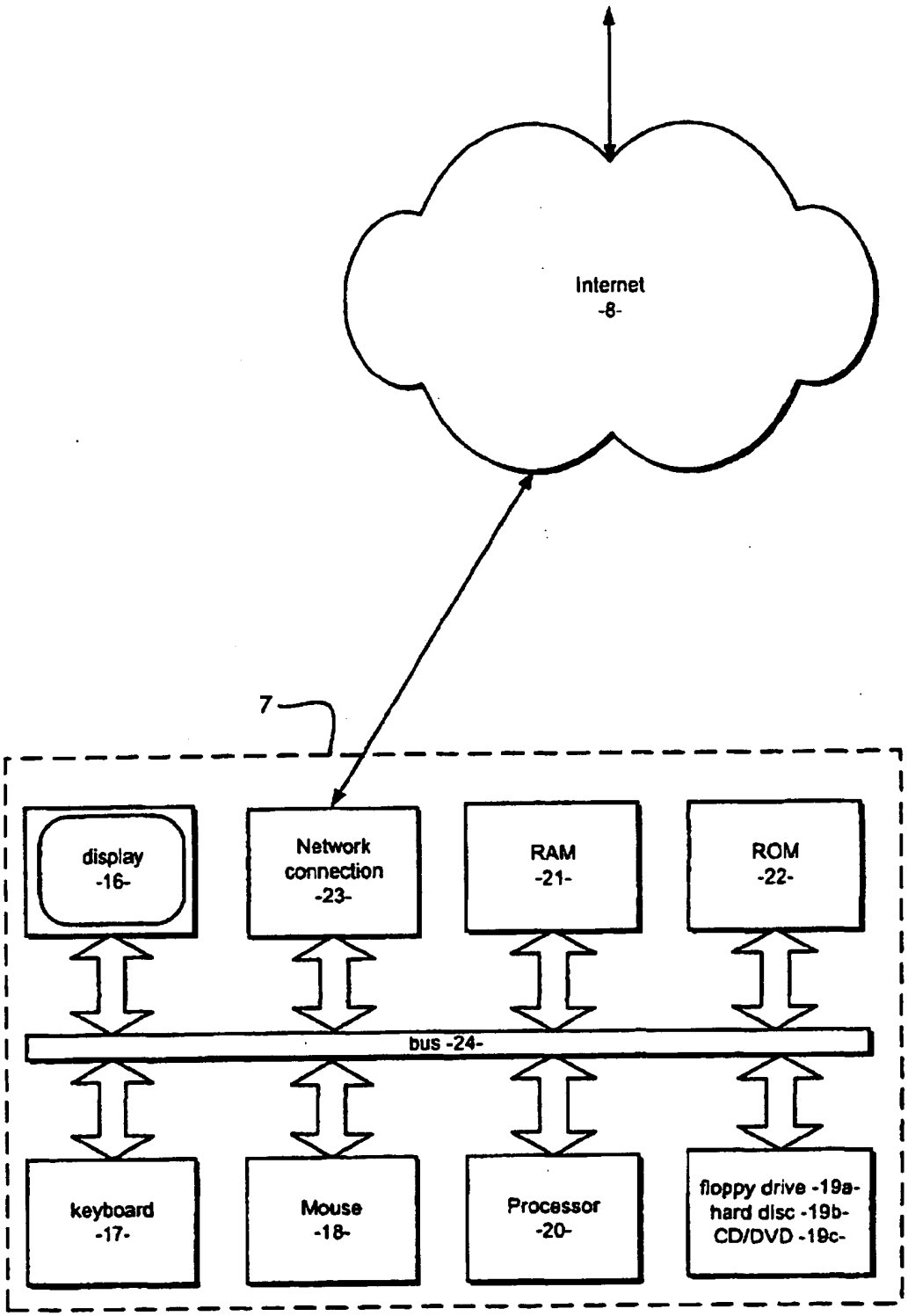


FIG. 3

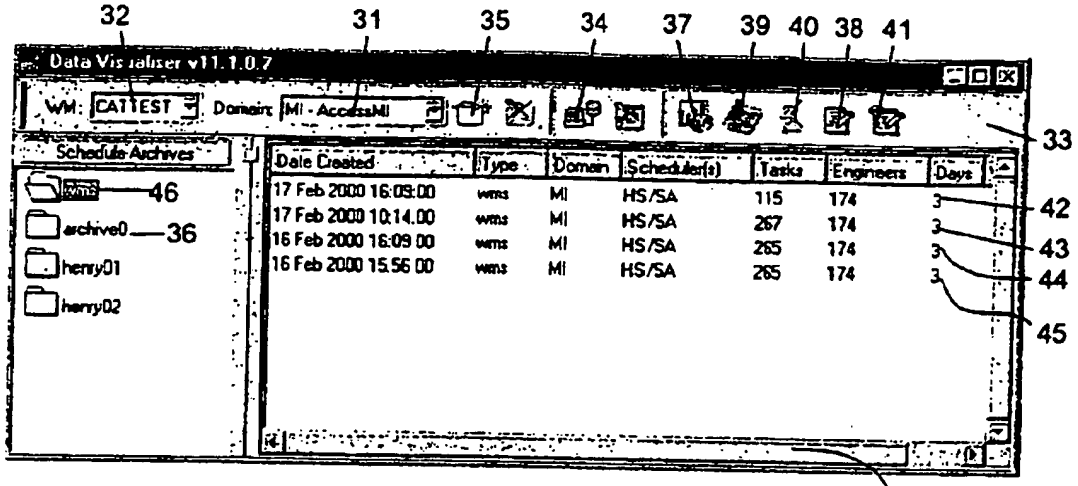


FIG. 5

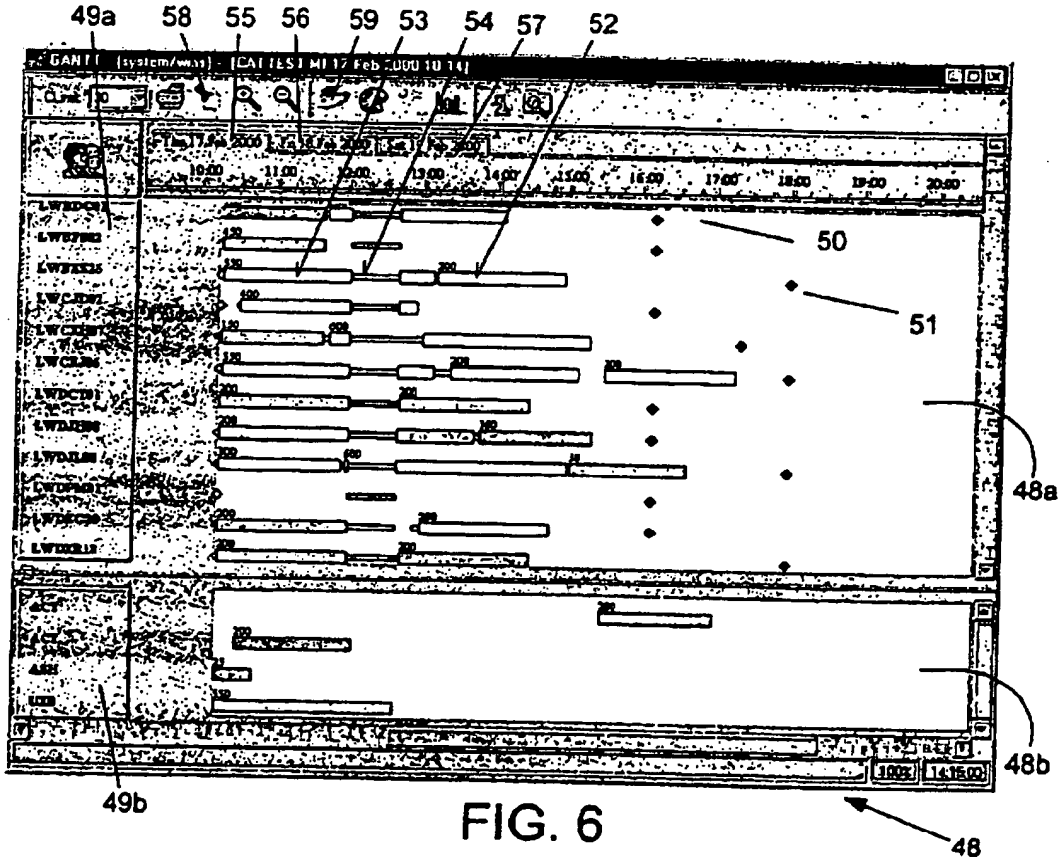


FIG. 6

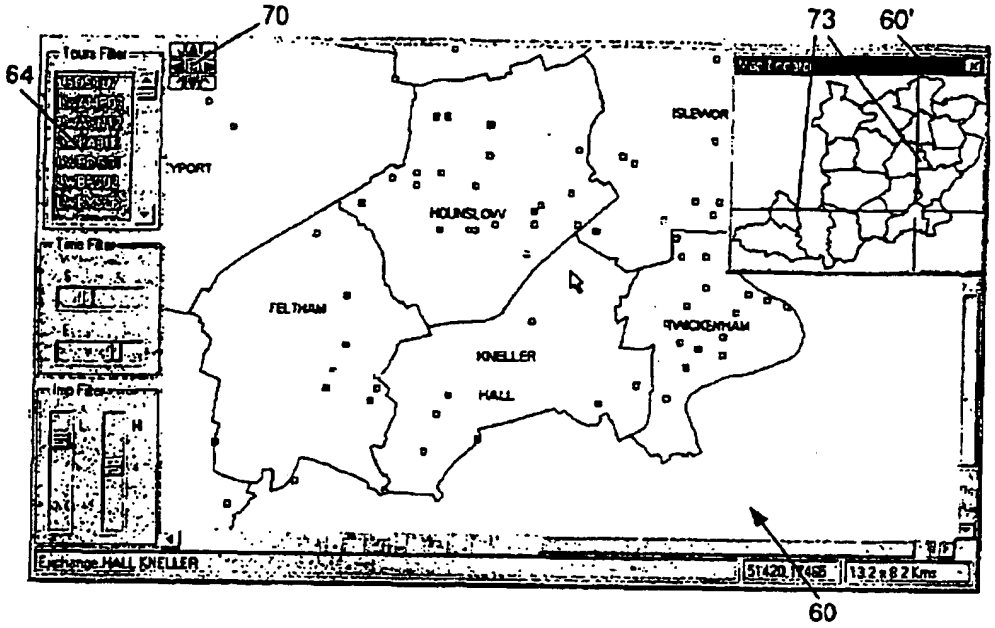


FIG. 9

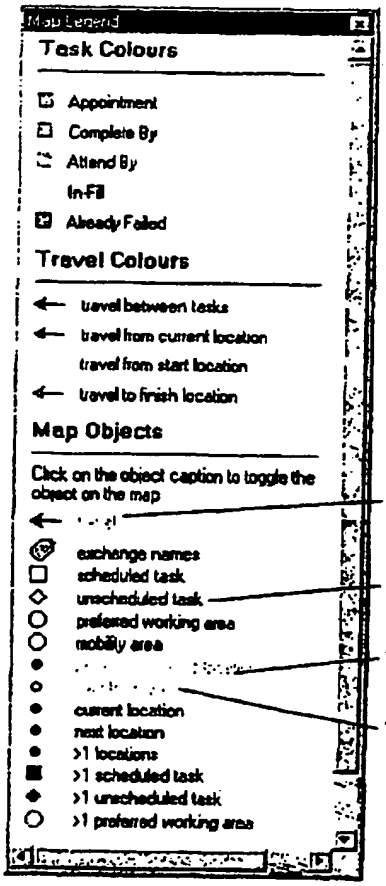


FIG. 10

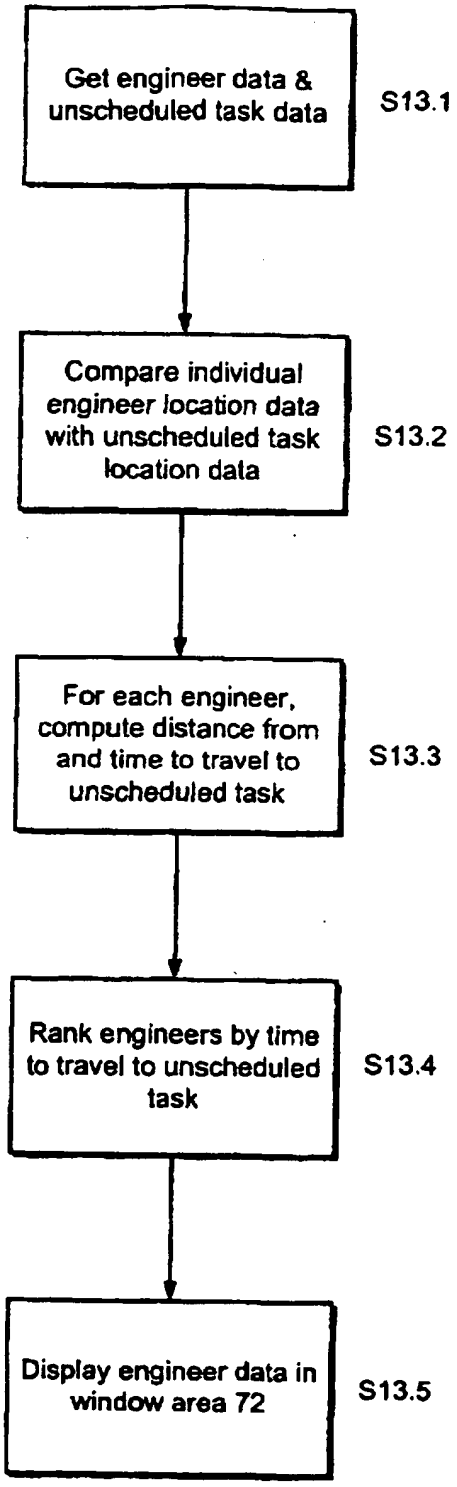


FIG. 13

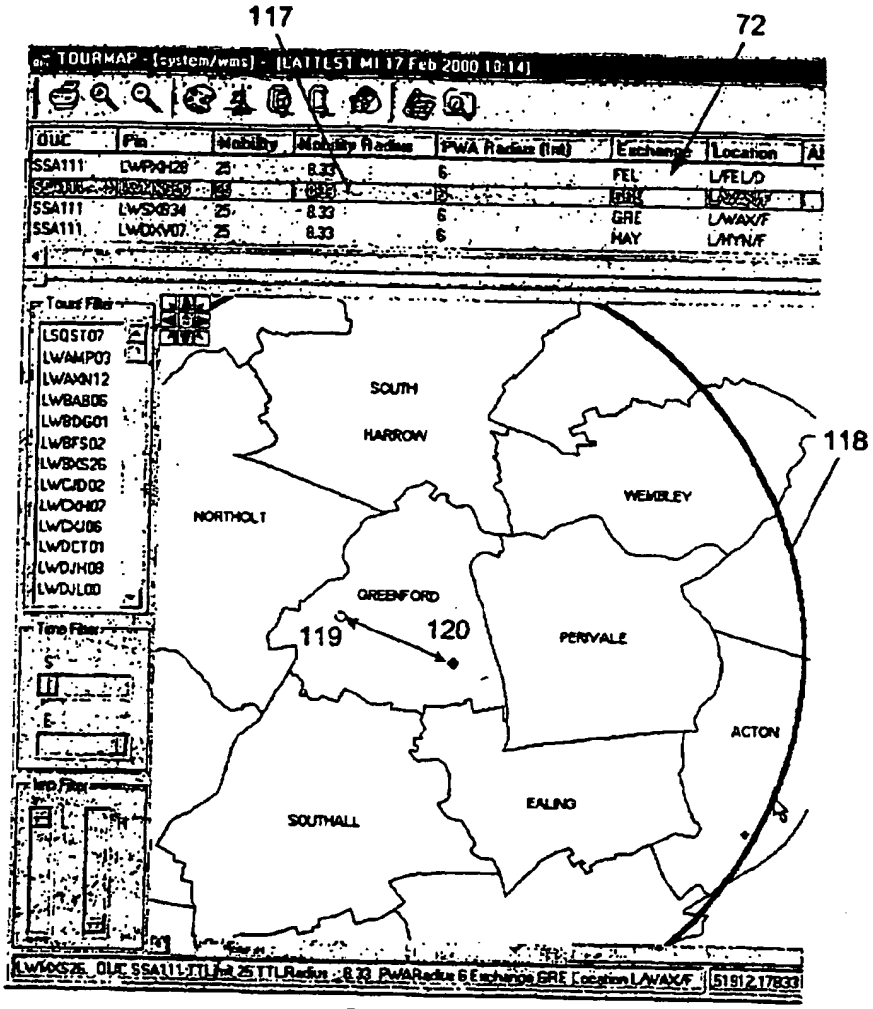


FIG. 16

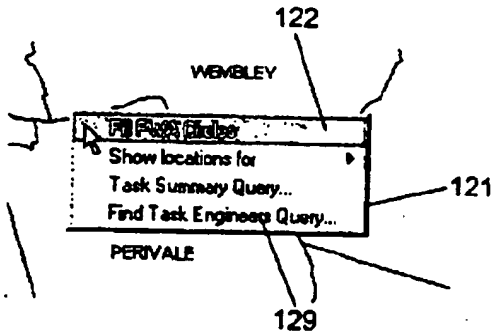


FIG. 17

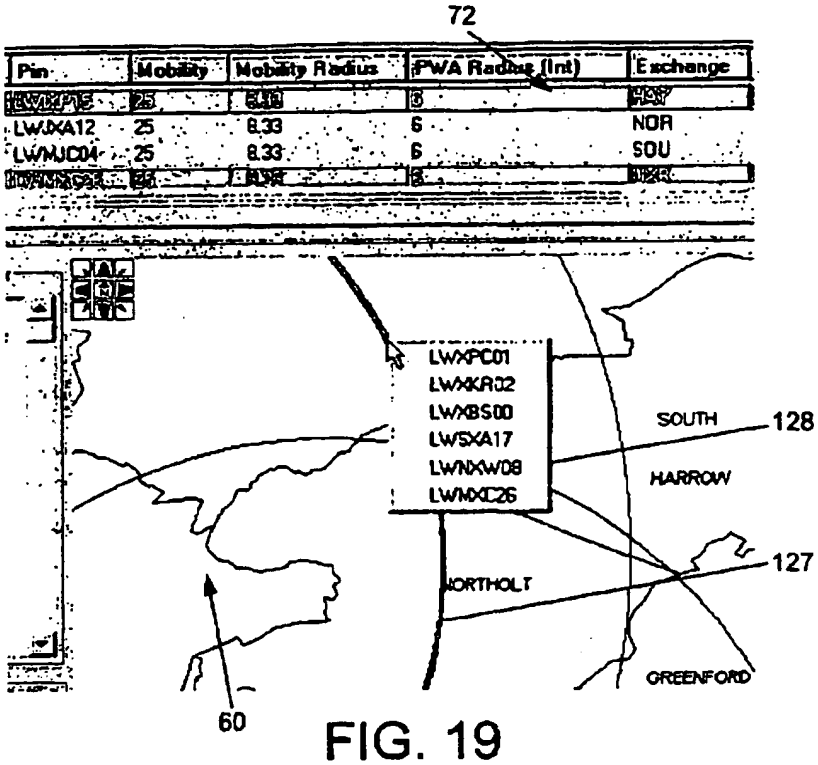


FIG. 19

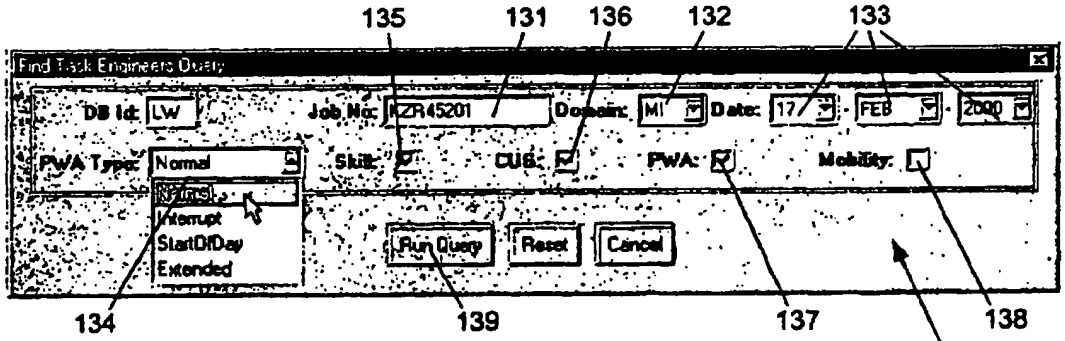
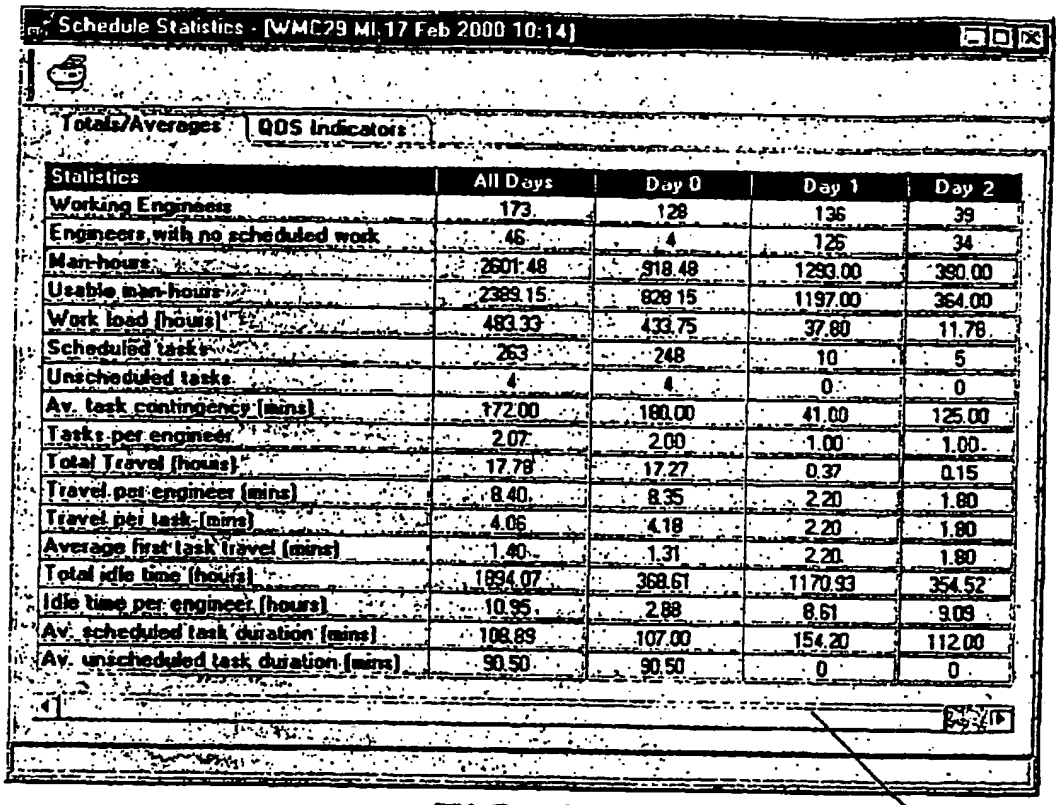
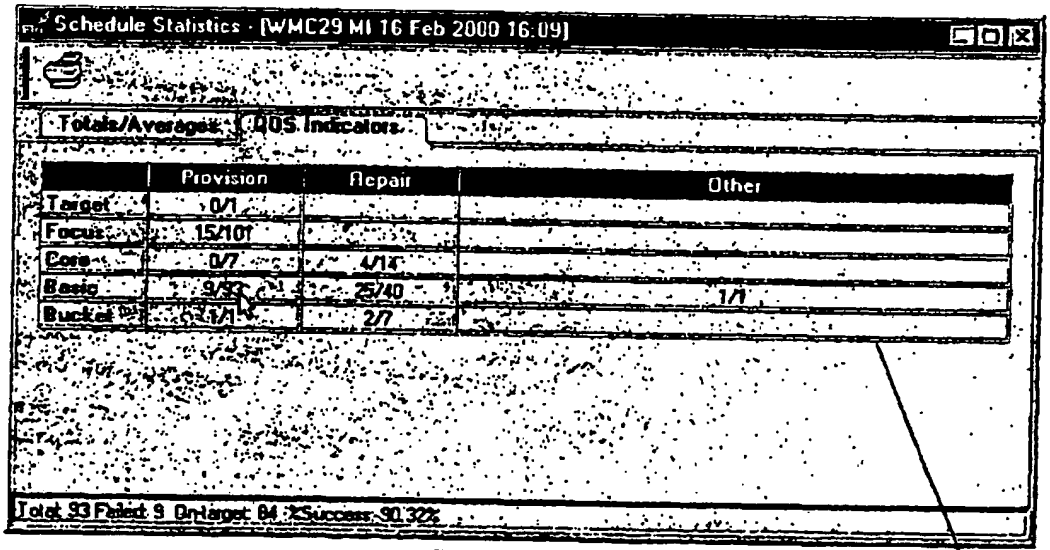


FIG. 20



Statistics	All Days	Day 0	Day 1	Day 2
Working Engineers	173	128	136	39
Engineers with no scheduled work	46	4	125	34
Man-hours	2601.48	918.48	1293.00	390.00
Usable man-hours	2389.15	828.15	1197.00	364.00
Work load (hours)	483.33	433.75	37.80	11.78
Scheduled tasks	263	248	10	5
Unscheduled tasks	4	4	0	0
Av. task contingency (mins)	172.00	180.00	41.00	125.00
Tasks per engineer	2.07	2.00	1.00	1.00
Total Travel (hours)	17.78	17.27	0.37	0.15
Travel per engineer (mins)	8.40	8.35	2.20	1.80
Travel per task (mins)	4.06	4.18	2.20	1.80
Average first task travel (mins)	1.40	1.31	2.20	1.80
Total idle time (hours)	1894.07	368.61	1170.93	354.52
Idle time per engineer (hours)	10.95	2.88	8.61	9.09
Av. scheduled task duration (mins)	108.89	107.00	154.20	112.00
Av. unscheduled task duration (mins)	90.50	90.50	0	0

FIG. 23



	Provision	Repair	Other
Target	0/1		
Focus	15/101		
Core	0/7	4/14	
Basic	9/33	25/40	1/1
Bucket	1/1	2/7	

FIG. 24

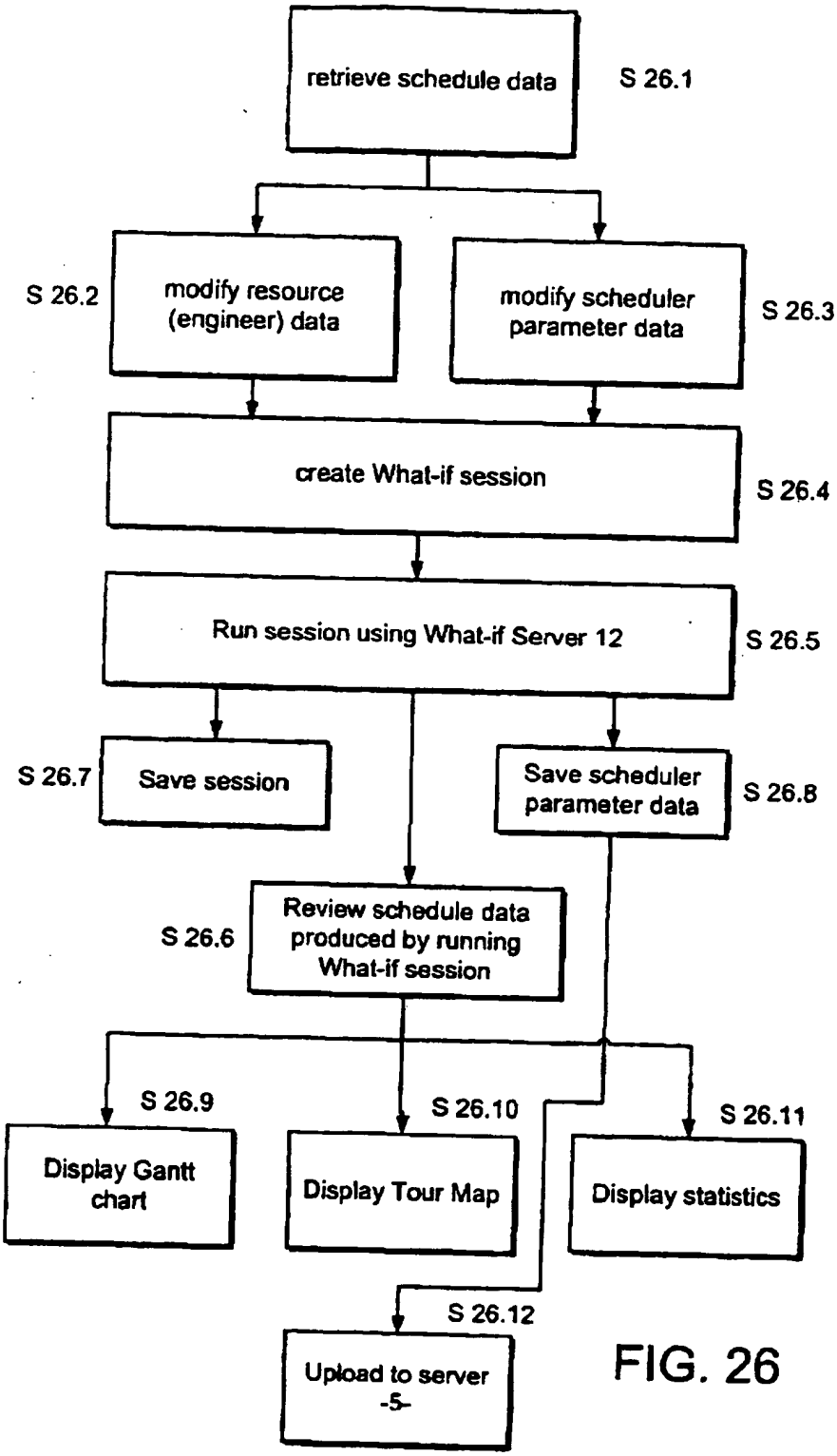


FIG. 26

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 00 30 2753

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	31 August 2000	FERNANDEZ FERRE.., M

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82